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WOOL SCOURING TESTS IN UTAH

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Bulletin 298

AGRICULTURAL EXPERIMENT STATION
UTAH STATE AGRICULTURAL COLLEGE
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Contents

WOOL SCOURING TESTS IN UTAH

Alma C. Esplin, Ralph W. Phillips, and Milton A. Madsen

WOOL, as it is shorn from the sheep, is known as grease wool. The first step in the manufacturing of wool is scouring, or removal of all grease and foreign matter. Within any given grade, as determined by length of staple and fineness of fiber, the yield of clean wool is the primary factor in determining the value of the original grease wool. The price of scoured or clean wool is multiplied by the percentage yield of clean wool to determine the value of the grease wool.

Wool is graded and sorted before being scoured by the manufacturer. Large quantities are prepared for the scouring vats and the identity of the grower's clip is lost. Hence, the grower is entirely dependent upon the buyer's estimate of shrinkage or yield of clean wool, unless he obtains a representative sample of his clip and has it scoured to determine the yield.

The objectives of the work reported in this bulletin were to obtain information on the variability in yields of clean wool in Utah herds, and to add to work already done on methods of sampling and determining yields. Three methods have been used: (1) whole fleece samples, (2) composite samples, and (3) side samples from individual sheep. Literature concerning each of these methods and other pertinent material is reviewed, and results obtained in Utah are presented.

Review of Literature

Estimates of Shrinkage

Von Bergen (6) gives the following approximate shrinkages for the various grades of wool from the farm and territory states:

Grade	Shrinkage		Yield	
	Farm states	Territory	Farm states	Territory
	percent	*percent*	*percent*	*percent*
Fine	60	67	40	33
½ blood	52	62	48	38
⅜ blood	46	54	54	46
¼ blood	43	48	57	52
Common	38	43	62	57

For Utah and surrounding states, Von Bergen gives shrinkages for the years 1934-35-36, which vary from 63 to 69 percent. Shrinkages of 66 percent are given in each of these years for Utah.

Allen (1) states that about 75 to 80 percent of Utah wools are original bag clips. He also states that Utah wools may be divided geographically and gives the range in shrinkages which applies to each group as is shown below.

	Average range clip	Uintah, Vernal; Watson, Craig	Ranch	Southern red and heavy
	percent	*percent*	*percent*	*percent*
Fine staple	(scarce)	60-64	61-65	
French combing	63-68	61-65	62-67	Mainly
Fine medium clothing	64-70	62-66	64-69	original
½ blood	57-62	56-61	57-62	bag
⅜ blood	53-56	52-55	53-56	
¼ blood	49-53	46-52	48-52	
Fine and ½ blood original bag	63-68	61-66	62-66	65-72

"Ranch" wool includes all farm flocks and wools grown on irrigated tracts or in ranch grass country. Allen states that the average shrinkage for the state, according to the United States Department of Agriculture, is 64 percent.

Hultz and Hill (12) give the following estimated shrinkages of wools from the eleven western states and Texas, along with estimates of the proportions of fine and medium wool produced in each state.

State	Estimated shrinkage	Kind of wool	
		Fine	Medium
	percent	*percent*	*percent*
Arizona	64	80	20
California	62	90	10
Colorado	63	70	30
Idaho	63	35	65
Montana	64	70	30
Nevada	67	80	20
New Mexico	68	90	10
Oregon	65	80	20
Texas	61	100	0
Utah	64	80	20
Washington	67	75	25
Wyoming	65	35	65

Burrus and Window (7) point out that the shrinkages of greasy shorn domestic wools from all wool-producing areas in the United States and all grades of wool range from a low of around 35 percent to a high of around 75 percent. The average shrinkage of domestic clips of recent years has been estimated by members of the wool trade and manufacturers at around 60 percent. This means that, on the average, only about 40 pounds of scoured wool will be obtained from 100 pounds of greasy shorn wools. A few of the lightest shrinking domestic wools may yield as much as

65 pounds of scoured wool, whereas many of the heaviest-shrinking domestic wools yield only 25 pounds of scoured wool per 100 pounds of greasy wool. Burrus and Window give the following approximate ranges in shrinkage of two well-known groups of domestic wools.

Grade	Fleece wools		Territory wools
	Bright	Semi-bright	
	percent	*percent*	*percent*
Fine	57-63	63-70	64-75
½ blood	52-58	57-64	58-67
⅜ blood	44-50	52-58	53-62
¼ blood	41-46	47-55	48-57
Low ¼ blood	38-43	43-50	44-53
Common braid	38-43	43-50	44-54

These shrinkage percentages were compiled from estimates reported by dealers, mill buyers, and investigators, who are experienced in handling or studying domestic wools. Although these percentages do not cover the entire possible range of shrinkage, Burrus and Window believe that they provide a fair representation of the situation that exists with regard to shrinkage of fleece and territory wool over a period of years.

Shrinkage figures of the type presented above are given as representative of the wools in the different areas. It should be borne in mind, however, that they are estimates, and that they do not take into account the wide variations in shrinkage of individual clips.

Whole Fleece Samples

Whole fleece sampling has been done on a large scale by the Texas Agricultural Experiment Station. According to Youngblood (18) the legislature of Texas made a special appropriation of $15,000 for the establishment by the experiment station of a wool and mohair scouring and grading plant, for the purpose of making tests of fleeces for the growers of the state. The extent to which the Texas program of wool scouring has been successful is indicated by the following quotation from Connor (8):

> Active operation of the plant was begun in 1921, and during the ensuing eight years, more than 48,000 pounds of wool, showing an average shrinkage of 60.5 percent, have been scoured for wool growers of Texas, aside from thousands of pounds from the Ranch Station flock which was scoured for experimental purposes. Valuable data have also been secured from scouring mohair samples.
>
> During the years 1918 and 1919, the estimated shrinkage of Texas wools was 67 percent, according to the annual *Wool Review* published by the National Association of Wool Manufacturers. In 1927, the same publication estimated the shrinkage of Texas wool as 61 percent, or 6 percent lower than in 1918 and 1919, before our wool scouring records were available. The wool growers

of Texas have attributed the lower estimated shrinkage to the results secured at the Wool Scouring Plant.

Estimating the 35,000,000 pounds of Texas wool as having a shrinkage of 61 percent, the total amount of clean wool would be 13,650,000 pounds. An error of 1 percent in estimating the shrinkage on such a basis would result in a gain or loss of 350,000 pounds of clean wool to the growers, worth in recent years about $1.00 a pound. Furthermore, the scouring records at the Wool Scouring Plant have revealed considerable regional variations which had hitherto not been apparent. For instance, Val Verde County, with approximately 400,000 sheep, producing around 8 pounds of wool per head, or 3,200,000 pounds annually for the county, has sent more than 17,000 pounds of samples for scouring, the average shrinkage of which was only 58.35 percent. These scouring tests have had their influence in lowering the estimated shrinkage of the wool produced in Val Verde County approximately 5 percent, which means for that county alone a saving of about $160,000 annually, based on a price of $1.00 a pound for clean wool . . . it was found that some Texas fine wool fleeces have a range in shrinkage from as low as 45 percent to as high as 75 percent.

Jones and Lush (13) made studies at the Texas Experiment Station of the number of fleeces necessary to represent the shrinkage of wool from a uniformly bred flock and concluded that 25 fleeces would assure an average shrinkage within 2 percent of the true value, and that 100 fleeces would be within 1 percent, provided they were selected by a fair method.

Esplin (10) reports results of a study in which whole fleeces from ewes wintered on the farm were compared with fleeces from ewes wintered on Utah desert ranges. The average yield of clean wool from farm-fed ewes was 39.1 percent, and for range ewes 34.2 percent.

Composite Samples

Various attempts have been made to develop methods of obtaining small samples from which the shrinkage of an entire clip could be determined. A few of the more recent findings are mentioned here.

Burns (4) reports that small samples, obtained by taking representative handfuls from 50 fleeces, are satisfactory for shrinkage tests as far as can be determined by correspondence of duplicate samples. He states that the expectancy is that duplicate samples will vary less than 2 percent in shrinkage. Burns checked the shrinkage of samples from 2 bags of wool against the shrinkage of the entire bag. One bag gave a shrinkage of 66.1 percent, while the sample gave a shrinkage of 66.8. The second bag gave figures of 60.6 for the entire bag, and 60.4 for the sample.

Burns (6) reports the results of nine years of tests of sampling at the shearing sheds to determine the shrinkage of large lots of wool. One or more sets of duplicate samples was taken from each of the clips studied. The results showed that the aver-

age difference between duplicate samples was 1.55 percent. It was less than 2 percent in three-fourths of the cases. There were scattered pairs in which the difference ranged from 4 to 6.5 percent. It was concluded that small samples can, in a large percentage of the cases, be counted upon as reliable indicators of the true shrinkage of the clips sampled.

Burns (5) states that for the first time we now have definite checks of the shrinkage of a series of small samples as compared with the shrinkage of the entire lot from which they were taken, when the entire lot was processed at the mill. The differences between the average shrinkage of the series of small samples and of the entire lot were all less than 2 percent. (In the past, when furnishing shrinkage information to wool growers, 2 percent difference in shrinkage between duplicate samples from the same band of sheep has been used as a practical limit of variation.)

Buck (2) states that samples having a minimum weight of from 6 to 7 pounds drawn from thoroughly blended samples of wool were shown to have a shrinkage within + or — 0.7 percent of the bulk from which they were drawn. This has been and should hold true no matter how heterogenous the original wool, and even if the subsample amounts to only 2 percent of the weight of the original wool.

Side Samples

Small side samples have been used by Spencer, Hardy, and Brandon (15) as indicators of the shrinkage of the entire fleece. In this study, the fleece was broken into seven parts—viz., neck, shoulder, back, sides, belly, rump, and breech. Studies of 50 Rambouillet and 48 crossbreed fleeces showed that the side samples were most nearly representative of the whole fleece, and averaged almost exactly the same percentage of clean wool as the whole fleece. Shoulder samples ranked second, and yielded approximately 3 percent more clean wool than the entire fleece. A modification of this method of obtaining small samples is described by Hardy (11).

Davis, Jones, and Warwick (9) studied the relation of shrinkages of small samples to shrinkages of the whole fleece. Each sample consisted of a large handful of wool from the shoulder area. Correlations of +0.86, +0.90, and +0.90 are reported in the different groups studied. These figures indicate that by scouring small samples, a reliable index of the entire fleece can be obtained.

Wilson (17) describes a method of obtaining small samples from which the clean weights of individual fleeces can be deter-

mined. Rather than taking samples from a specific area, the fleece is put through a breaker and then three small samples are drawn from as many different portions of the broken fleece.

Moisture Regain

Closely associated with problems of determining shrinkage is the problem of determining accurate weights owing to moisture variations. Wool growers have been aware of a change in weights owing to moisture but have been at a disadvantage in obtaining uniform practices in calculating moisture regains.

Wool is sensitive to moisture. It absorbs relatively large amounts when the humidity and temperature are high and loses large amounts when the humidity is low and the temperature high. The variation in moisture is 4.5 percent when atmospheric humidity changes from 50 percent to 70 percent at 75°F. according to Mathews (14), or 4½ pounds on each 100 pounds of wool. Even higher gains and losses are sustained under more extreme conditions. Hultz and Hill (12) state that wool from the arid states gains in weight upon being stored in warehouses along the Atlantic seaboard. The greater proportion of sand in the wool, the less the gain in weight in storage. The more suint in wool, the greater will be the increase in weight while stored in the East. In the mountain states during the summer when the days are hot and dry and the nights are cool, wool spread out in thin layers exposed to the air may weigh several pounds more to the hundred early in the morning than in the midafternoon. Sacked or baled wool, especially when stored in large piles in closed warehouses, changes in moisture content very slowly. If it is desired to hasten this process, the wool should be spread out and the packages opened and handled in a place where there is free circulation of air.

Buck and Le Compte (3) conducted experiments which showed that cooperating laboratories cannot attain good agreement in the shrinkages of duplicate samples of wool unless they make allowance for the variation in the moisture content of the grease wool. This conclusion is based on the fact that a variation actually demonstrated to be the result of the difference in moisture content in the grease wool was 0.81 percent. The maximum variation that might possibly be obtained because of this factor was estimated to be as much as 4.77 percent. These workers also point out that good agreement will not be attained in the shrinkage of duplicate samples of wool unless allowance is also made for the amount of moisture contained in the scoured wool.

The maximum variation actually demonstrated to be caused by this factor was 1.20 percent. The greatest difference in shrinkage results that could possibly be obtained because of the varying amount of moisture in scoured wool was estimated to be 4.68 percent.

Material and Methods

THE methods of obtaining and scouring samples used in this study are outlined briefly below.

Whole Fleece Samples

Whole fleece samples were obtained at shearing corrals. Twenty-five fleeces from a herd of 2,000 to 3,000 sheep were considered a minimum sample. In many cases, more fleeces were obtained. Fewer fleeces were used only in smaller herds or in farm flocks of a few hundred head.

At the shearing corrals, each tenth fleece was put aside as it reached the sacker until the sample of 25 or more fleeces was obtained. These fleeces were sacked and labeled for shipment to a commercial plant,[1] where they were scoured. The commercial scouring equipment was thoroughly cleaned by the mill foreman, and the vats refilled for use in this work. The method of scouring used was as follows:

The grease wool was weighed after having been stored in the warehouse for approximately 30 days. It was then put through a breaker to remove a considerable quantity of dirt. From the breaker, it was put directly into the first scouring vat, which contained the following solution:

Soap	2 pounds
Sal soda	1 pound
Water	20 gallons

After scouring in this vat, it was put through a wringer and transferred to the second vat which contained a solution of the same composition. It was then put through another wringer and placed in the third vat which contained water for rinsing. Temperature in all vats was held between 120° and 130° F. The scoured wool was passed through a third wringer and dried in an artificial drier. It was then stored in the warehouse for approximately 30 days before final weighing.

Daily weights were taken. When these weights remained reasonably constant for three or four days, the average of these

[1]Utah Woolen Mills, Murray.

figures was taken as the scoured weight. Shrinkages and yields of clean wool were determined, using these weights of the scoured wool, and the weight of the grease wool obtained just before scouring.

The numbers of flocks from which whole fleece samples of each grade were obtained and the total amounts of wool scoured are given in table 1.

Table 1. *Numbers of flocks from which whole fleece samples were obtained, by grades, in each year and the amounts of wool scoured*

Year	Grade							
	Fine		½ blood		⅜ blood		¼ blood	
	Flocks sampled	Wool scoured	Flocks sampled	Wool scoured	Flocks sampled	Wool scoured	Flocks sampled	Wool scoured
	number	*pounds*	*number*	*pounds*	*number*	*pounds*	*number*	*pounds*
1935	26	5,569.0	19	1,535.0	7	466.0	3	82.5
1936	8	1,612.5	4	491.0	0	0	0	0
1937	7	668.0	6	826.0	6	393.0	1	38.0
1938	5	371.5	6	729.2	6	532.5	2	89.5
1939	2	214.5	3	363.0	4	327.0	0	0
Totals	48	8,435.5	38	3,944.2	23	1,718.5	6	210.0

Composite Samples

Composite samples were drawn from herds at shearing time, and in a few instances, from clips in the warehouses.

At the shearing corral samples were taken either by sampling all fleeces from a certain number of shearers, or all fleeces from the shearing floor until the complete sample was obtained. The beginning and end of the shearing period were avoided. A few handfuls of wool were taken from the various parts of each fleece and placed in sample bags by grades. This procedure was continued until a minimum of 50 fleeces was sampled. As many as 200 were taken from herds that were producing several grades of wool.

Samples that were obtained from the warehouse were taken by opening bags from different portions of the clip. From 2 to 5 bags were opened, depending upon the size of the clip. The sampling procedure was then the same as that followed at the shearing corrals.

All samples were drawn and scoured by grades in the wool labratory of the Agricultural Experiment Station at Logan, using essentially the same procedure as that followed in the scouring

of whole fleeces, with the exception that the wool was allowed to air dry on racks rather than being put through an artificial drier. The scouring equipment is shown in figure 1.

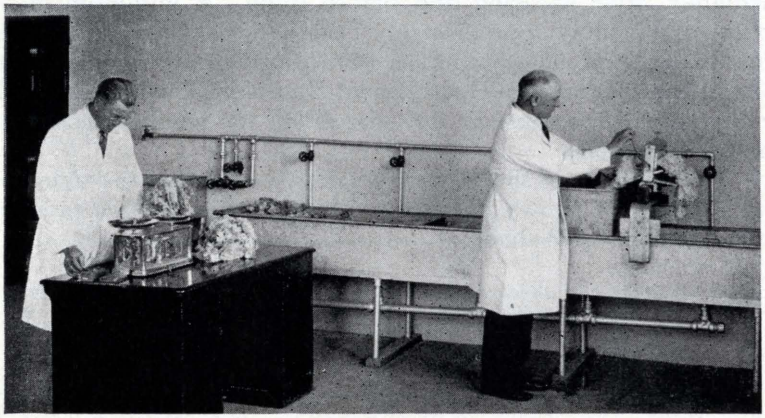

Figure 1. Wool scouring equipment in the Agricultural Experiment Station's wool laboratory

The total number of flocks from which composite samples were taken, and the number of samples in each grade are shown in table 2. Composite samples were not obtained from the same herds as were whole fleece samples, except where whole fleeces and composite samples were taken from the same herd in different years.

Table 2. *Number of composite samples obtained and scoured*

Year	Total flocks sampled	Number of samples, by grade		
		Fine	½ blood	⅜ blood
	number	*number*	*number*	*number*
1938	10	10	1	1
1939	14	13	5	4
1940	14	14	3	2
Totals	38	37	9	7

Side Samples

Side samples have been taken from a few purebred herds and from a group of experimental lambs. The purebred herds included Corriedale, Hampshire, Rambouillet, and Southdown flocks at the Utah State Agricultural College, and Rambouillets

at the Branch Agricultural College and one cooperator's herd. The experimental lambs were grade Rambouillets that were sampled at about one year of age.

The samples were taken from the side of the fleece, immediately after shearing and before tying. A minimum of ½ pound, and usually approximately 1 pound, was taken as a sample from each sheep. These samples were scoured in the wool laboratory at the Agricultural Experiment Station, following essentially the same procedure as that described for whole fleeces and composite samples.

The numbers of sheep from which side samples were obtained and scoured are shown in table 3. These studies include samples from a total of 1,083 sheep.

Table 3. *Numbers of animals from which side samples were scoured, by breeds*

Year	Utah State Agr. College flock				Branch Agr. College flock	Cooperator's flock	Experimental ewe lambs (grade Rambouillets)			
							Farm fed during winter		Range	
	Rambouillet	Corriedale	Hampshire	Southdown	Rambouillet	Rambouillet	Fine	½ blood	Fine	½ blood
	number	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*	*number*
1936	29	16	18							
1937	46	26	25				59	14	34	4
1938	39	16	21		97		46	20	36	5
1939	53	24	6		80	53	45	16	30	1
1940	38	34	14	11		127				
Totals	205	116	84	11	177	180	150	50	100	10

Data and Discussion

Whole Fleece Samples

The average yields of clean wool obtained each year in each grade are presented in table 4, along with the averages of the various grades for all years included in the study. The figures

Table 4. *Average percentages of clean wool, found in whole fleece samples, by grades in each year*

Year	Grade			
	Fine	½ blood	⅜ blood	¼ blood
	percent	*percent*	*percent*	*percent*
1935	32.10	37.63	40.23	45.26
1936	32.02	31.56	.....	.....
1937	33.67	41.00	46.97	51.95
1938	35.48	40.28	41.04	45.90
1939	38.56	41.42	42.95	.....
Weighted average	32.94	38.24	42.67	46.59

in this table were obtained by averaging the yields for all clips in each group. The number of clips and amounts of wool upon which these figures are based are given in table 1.

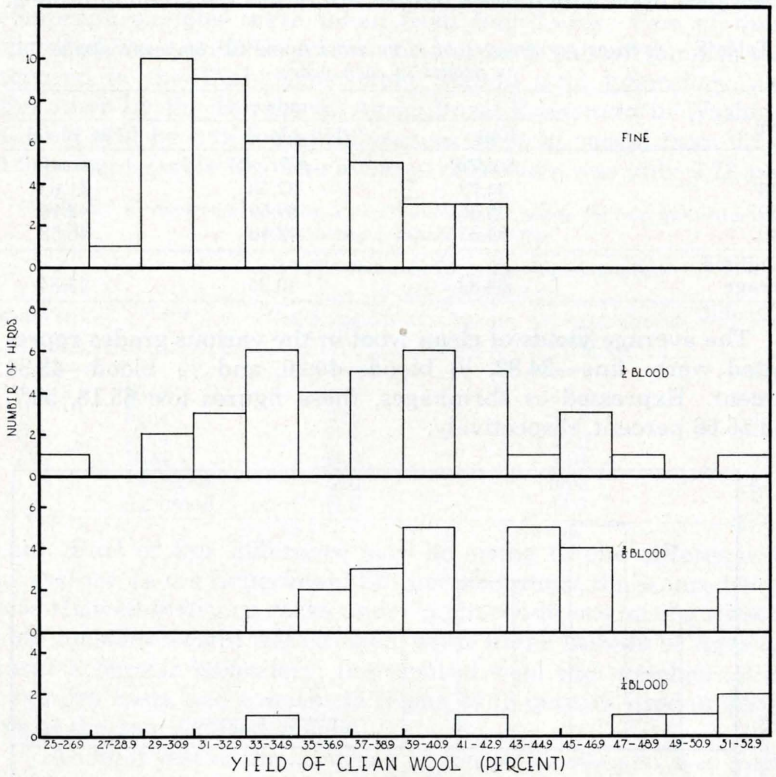

Figure 2. Distributions of yields of clean wool in herds, as determined by scouring tests of whole fleece samples

The average yields of clean wool in the various grade groups were: fine—32.94, ½ blood—38.24, 3/8 blood—42.67, and ¼ blood —46.59 percent. In terms of shrinkages, these figures are 67.06, 61.76, 57.33, and 53.41 percent, respectively.

Wide variation existed in the yields of clean wool in each grade of wool (fig. 2).

Composite Samples

The average yields of clean wool obtained from composite samples by grades, in each of the years are given in table 5, along

with averages for the three years. These figures are averages of all samples included in each group, regardless of the size of sample or size of clip from which they were drawn. The numbers of samples upon which these figures are based are given in table 2.

Table 5. *Average percentages of clean wool found in composite samples by grades in each year*

Year	Grade		
	Fine	½ blood	⅜ blood
	percent	*percent*	*percent*
1938	34.77	37.58	41.63
1939	35.36	39.69	42.16
1940	34.35	42.10	46.58
Weighted average	34.82	40.26	43.34

The average yields of clean wool in the various grades represented were: fine—34.82, ½ blood—40.26, and ⅜ blood—43.34 percent. Expressed as shrinkages, these figures are 65.18, 59.7, and 56.66 percent, respectively.

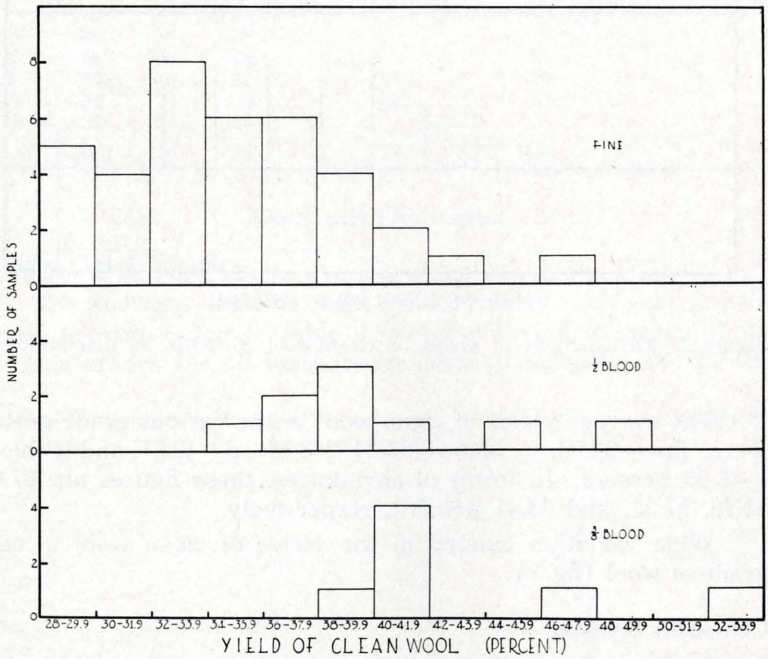

Figure 3. Distributions of yields of clean wool in herds, as determined by scouring tests of composite samples

Wide variations in the yield of clean wool were found in all grades of wool (fig. 3).

Some tests were made in 1938 which give an indication of the reliability of yields obtained from composite samples. Duplicate composite samples were taken from four herds. One of these included wool of three grades. One of each pair of samples was scoured in the Utah Experiment Station wool laboratory, and the other by the Bureau of Agricultural Economics in Washington. It will be noted that differences in yield varied from 0.2 to 1.9 percent (table 6). The average difference was only 0.73 per-

Table 6. *Comparison of results of scouring tests made by two laboratories on duplicate composite samples*

Clip sampled	Grade	Yields obtained from duplicate samples in two laboratories		Difference
		Utah Experiment Station	Bureau of Agricultural Economics	
		percent	*percent*	*percent*
A	Fine	39.7	41.6	1.9
B	Fine	30.6	31.0	.4
C	Fine	37.3	39.0	1.7
D	Fine	34.0	33.8	.2
	½ blood	37.6	38.2	.6
	⅜ blood	41.6	41.3	.3

cent. Part of this difference may be owing to one difference in procedure. In the Experiment Station laboratory, the scoured wool was allowed to dry on racks under room conditions until a reasonably constant weight was reached, while in the Bureau of Agricultural Economic laboratory, the scoured wool was weighed on an oven-dry basis, and a moisture regain of 13 percent used in arriving at the final scoured weight.

Another test of the accuracy of composite samples was made in 1940 when three bags of wool of three different grades were scoured for comparison with the results of composite samples from the same bags. The bag lots were scoured in a commercial manufacturing plant,[2] and the composite samples in the Utah Experiment Station wool laboratory. The yields were as follows:

Grade	Yields of whole bags	Yields of composite samples
	percent	*percent*
Fine	34.94	35.84
½ blood	38.84	39.73
⅜ blood	40.18	40.84

These results indicate close agreement between composite samples and whole bag.

[2]Eavenson and Levering Co., Camden, N. J.

Side Samples

The flocks and breeds from which side samples from individual sheep were obtained and scoured are indicated in tables 7 and 8, along with the average yields of clean wool in each group. The numbers of animals upon which these averages are based are given in table 3.

The sheep represented in table 7 were maintained the year around under farm conditions, i. e., in sheds and dry lot. It will

Table 7. *Average yields of clean wool from side samples of individual ewes in the U. S. A. C. flock*

Year	Rambouillet	Corriedale	Hampshire	Southdown
	percent	*percent*	*percent*	*percent*
1936	*39.55	50.51	55.07	
1937	47.10	56.20	54.00	
1938	43.37	53.57	51.94	
1939	47.41	55.98	55.49	
1940	43.88	53.50	50.84	45.74
Weighted average	44.81	54.21	53.30	45.74

*Includes 14 purchased Rambouillet yearling ewes.

be noted that the average yield of clean wool for the Rambouillets was 44.81 percent as compared to yields of 54.21 and 53.30 percent for Corriedales and Hampshires. Yields are available for the Southdown breed in only one year, in which the average yield was 45.74 percent. In terms of shrinkages, the above figures for Rambouillets, Corriedales, Hampshires, and Southdowns are 55.19, 45.79, 46.60, and 54.26 percent, respectively.

Table 8. *Average yields of clean wool from side samples of individual ewes from the Branch College flock and two other groups of sheep*

Year	Branch College flock (Rambouillet)	Cooperator's flock (Rambouillet)	Experimental ewe lambs (grade Rambouillet)			
			Farm fed during winter		Range	
			Fine	½ blood	Fine	½ blood
	percent	*percent*	*percent*	*percent*	*percent*	*percent*
1937			55.59	57.50	47.51	42.10
1938	41.69		52.74	51.50	42.41	46.30
1939	43.31	37.76	51.23	53.94	46.22	38.85
1940		35.30				
Average	42.47	36.02	53.41	54.17	45.30	43.62

The Branch Agricultural College Rambouillet sheep, data from which are shown in table 8, were farm fed in winter and ranged on mountain land during the summer. In this herd, the

average yield of clean wool was 42.47 percent. The cooperator's herd of Rambouillet sheep was grazed most of the year on ranges varying from 6,000 to 8,000 feet elevation and fed only during the winter when range conditions were severe, and during the lambing season. The average yield of clean wool in this herd was 36.02 percent. The management practices probably account for a large part of the difference in wool yields in the different herds of purebred Rambouillets.

The results with experimental ewe lambs reported in table 8 make possible a direct comparision between farm-fed lambs and lambs ranged on the desert from October to April. From birth until October, both groups were maintained under range conditions in southwestern Utah.

The figures are also indicative of yields of clean wool from lambs under farm and range conditions for fine and 1/2 blood wool in Utah. The differences in favor of farm sheep are in agreement with those reported by Esplin (10) for fleeces from mature ewes.

The variability in yields of clean wool from individual sheep, as indicated by side samples is shown in graphic form in figure 4 for each of the groups of sheep for which averages are given in tables 7 and 8.

Application of Results

The results of scouring tests of whole fleeces and composite samples presented in this bulletin indicate that wide variations exist in the shrinkages, or yields of clean wool, of Utah's wool clips. Estimated average shrinkage figures for the state are useful only to indicate the approximate shrinkages of wools coming from the state, and do not provide a fair basis for the sale of wool. The buyer's estimate of the shrinkage that is made merely from an examination of the grease wool cannot be expected to give a true picture of the clip. An error of 2 percent on a clip of 40,000 pounds of wool means an error of 800 pounds of clean wool. If the error is against the grower and if clean wool is worth 95 cents a pound, this means a loss of $760, or many times the cost of taking and scouring a composite sample.

If the price of wool is based on estimates that approximate the shrinkage figure that is believed to be typical of the area, the grower that is producing high-shrinkage wools receives an unfairly high price for his clip, while the grower that is producing low-shrinkage wools is penalized. Because wool has generally been bought on this basis, many growers have continued to breed sheep with high-shrinking wools, and have not used management

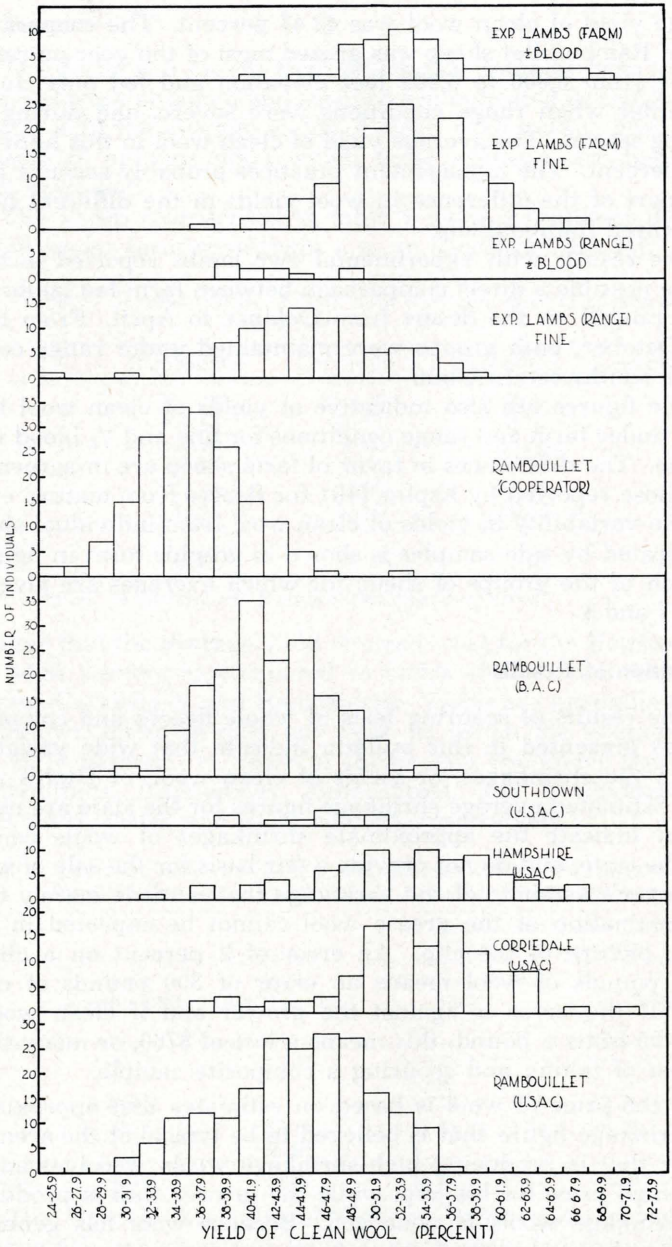

Figure 4. Distributions of yields of clean wool from individual sheep, as determined by scouring tests of side samples

practices which would decrease the shrinkage of their wool. Such buying practices, and the resulting breeding and management practices, are undesirable from the standpoint of both the producer and the wool trade.

These practices can only be changed by adoption of tests of shrinkage which give both the producer and the buyer a reasonably accurate determination of the shrinkage, or yield of clean wool. With this information, and with knowledge of staple length and grade, a fair price for the clip can be arrived at that is based on a test rather than a guess.

Sufficient evidence is now available to indicate that the scouring of a carefully selected composite sample gives a reasonably accurate determination of the yield of clean wool, and this method is adapted to wide use throughout the range country. The small errors involved in the method will fall on the buyer's side as frequently as on the side of the grower. Use of this method makes possible the testing of a large number of herds at a minimum cost.

After the grower knows the yield of clean wool of his clip, he can easily determine the price he should have for the grease wool. For example, if scoured wool of a certain grade is quoted at 95 cents on the Boston market, and the clip will yield 41 percent clean wool, the value of the grease wool in Boston is determined as follows:

$0.95 price of scoured wool per pound
.41 yield of clean wool (in percent)

$0.3895 value of grease wool per pound

A deduction of from 3 to 5 cents per pound should be subtracted from the Boston market price for freight and handling charges to determine Utah prices. If these charges are estimated at 4 cents per pound, the grower should expect to receive approximately 35 cents per pound for this wool.

If the grower is assured a fair price for his clip, on the basis of the clean wool, he can change his management practices so as to produce wools of less shrinkage. Early shearing, shearing before trailing to summer ranges, and the development of water on desert ranges to avoid long trails are some practices which will tend to reduce shrinkages.

Wool scouring tests might be made at a central laboratory, or warehouses maintained by the growers could be equipped at a small expense so that the scouring could be done by a ware-

house employee. The process is not difficult and can be carried out by any careful worker after he has had a little instruction. Scouring in growers' warehouses has an advantage over a central laboratory in that the growers can see their wool scoured and can compare their clips with others being produced in the vicinity. This practice would also encourage the grower to become acquainted with the grades and other qualities of the wool he is producing.

The results obtained from scouring tests of side samples from individual sheep show that wide variations exist between individuals within a breed in the same flock. These results indicate posibilities for increasing the percentage yield of clean wool by selection for sheep that produce light-shrinking fleeces. Improvement in this direction can be made most rapidly if the producers of rams that are to be used on range herds make use of individual side samples in evaluating their breeding animals. The range producer who is buying rams might well insist that they be tested for shrinkage as one basis for selection.

It is obvious that the scouring tests of either composite or whole fleece samples recommended are not absolutely accurate, but it also seems obvious that they give a far more accurate figure than can be expected from guesses. There is still need for much work to improve the methods of sampling, particularly with composite samples, so that the most representative sample will be obtained. The best means of insuring this improvement in methods is to put those now available into use. For example, the Babcock test for butterfat in milk has been accepted and has been in general use for many years, yet work is still being done to improve the accuracy of this test.

The equipment for scouring wool samples is not expensive. The equipment shown in figure 1 was constructed at a cost of $110, exclusive of the wringer and the plumbing. Scouring vats and wringer, a source of hot water, drying racks, and a scale are all the pieces of equipment that are necessary. A maximum of two days would be required for one man to obtain a composite sample of a clip from 2,000 sheep and to make the scouring test. If yields of clean wool are to be reported on the basis of a standard moisture regain, rather than on the basis of the air-dry scoured sample, a laboratory oven with electricity or some other source of heat would be required.

SUMMARY

RESULTS of wool scouring tests in Utah are reported. Tests of 115 whole fleece and 91 composite samples from herds, and side samples from 1,083 individual sheep are included. The findings are summarized briefly below:

1. The average yields of clean wool from whole fleece samples of the different grades were: fine—32.94, ½ blood—38.24, ⅜ blood—42.67, and ¼ blood—46.59 percent. In terms of shrinkages, these figures are 67.06, 61.76, 57.33, and 53.41 percent respectively.
2. The average yields of clean wool from composite samples of the various grades were: fine—34.82, ½ blood—40.26, and ⅜ blood—43.34 percent. Expressed as shrinkages, these figures are 65.18, 59.70, and 56.66 percent respectively.
3. Seven tests of duplicate composite samples, scoured in different laboratories, showed an average difference of 0.73 percent. The differences ranged from 0.2 to 1.9 percent.
4. Wide variations were found in the yield of clean wool within grades in the herds tested, both in the tests of whole fleeces and of the composite samples.
5. Average yields of clean wool from individual sheep in the Utah State Agricultural College flock, as indicated by tests of side samples, were as follows for the various breeds: Rambouillet—44.81, Corriedale—54.21, Hampshire—53.30, and Southdown—45.74 percent. In terms of shrinkages, these figures are 55.19, 45.79, 46.60, and 54.26 percent, respectively.
6. Average yields of clean wool in the Branch Agricultural College flock and in the herd of a cooperator, as indicated by scouring tests of side samples, were 42.47, and 36.02 percent. Expressed as shrinkages, these figures are 57.53, and 63.98 percent, respectively.
7. Tests of individual side samples from a group of grade Rambouillet experimental lambs showed that lambs which were farm fed during the winter gave higher yields of clean wool than those wintered on the range. The average yields of clean wool from lambs producing fine wool were 53.41 in the farm-fed group and 45.30 percent in the range group. For lambs producing ½ blood wool, the yields were 54.17 and 43.62 percent respectively.

8. Wide variations were observed in the yield of clean wool from individual sheep in all the groups studied. These variations indicate the possibilities of considerable increase in the yields of clean wool through breeding and selection.

On the basis of the findings summarized above and the literature reviewed, it is recommended that:

1. Scouring tests of carefully selected composite samples should be used as a basis for estimating the yield of clean wool in determining the price of the grease wool. These tests are generally applicable to the range area and are inexpensive. They could be carried out in a central laboratory, or in warehouses manitained by growers. Whole fleece samples may also be used if adequate scouring facilities are available.
2. Scouring tests of individual side samples should be used as one measure of the merit of individual sheep in the flocks of breeders that are producing rams for use in range herds. Purchasers of range rams would find this information a valuable guide in selecting rams, and the producer could use it to good advantage in evaluating individuals and in the progeny testing of rams.

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Glossary

Bright wool. Wool that is white and attractive, as contrasted to semi-bright and dingy or stained wool.

Clip. The wool produced by one wool grower, or from one herd of sheep.

Domestic wool. Wool produced in the United States. (Approximately half the wool consumed in this country is imported.)

Fleece. The wool produced by one sheep considered as a unit.

Fleece wool. An American trade name used to designate wool from states east of the Missouri River.

Grading. Classifying the unopened fleeces according to fineness and length. U. S. official grades are:

Grade (Fineness)		Length		
American grades	English system	Clothing	French combing	Strictly combing
		inches	*inches*	*inches*
Fine	80's, 70's, 64's	Under 1¼	1¼-2	Over 2
½ blood	60's, 58's	Under 1¼	1¼-2¼	Over 2¼
⅜ blood	56's	Under 1½	1½-2½	Over 2½
¼ blood	50's, 48's	Under 1½	1½-2¾	Over 2¾
Low ¼ blood	46's	Under 2	2-3	Over 3
Common	44's	(usually strictly combing)		4-10
Braid	40's, 36's	(usually strictly combing)		4-10

In the English system of grading a numerical scale is used in which the finest wool is designated as 80's and the coarsest wool as 36's. These numbers indicate the number of hanks of yarn (a hank contains 560 yards) that can be spun from a pound of wool. The finer the wool the more hanks that can be spun.

Grease wool. Wool that has not been washed or scoured.

Mohair. Long lustrous fiber from the Angora goat.

Mixed clip. Clip containing more than one grade of wool. Must be graded before going to the manufacturer.

Original bag wool. Clip of wool of one grade, or which is sufficiently uniform to go to the manufacturer without grading.

Scoured wool. Wool from which the natural impurities and dirt have been removed. It may be scoured by the emulsion process (using hot solutions of soap and sodium carbonate) or by the solvent process (using naptha or some other volatile solvent).

Semi-bright wool. Wool that is dull in color as that from "burned over" country, in contrast to bright wool.

Shrinkage. The weight the grease wool loses when it is scoured, expressed as percentage of the original weight.

Sorting. The process of separating fleeces into parts according to fineness and length. This process is different from grading where each fleece is kept intact.

Suint. The dried perspiration that accumulates in the fleece.

Territory wool. Wool from the states west of the Missouri River, or west of about the 106th meridian. Wools from Texas, California, Oregon, and from other states are usually quoted separately, and those from Nebraska, Oklahoma, and Kansas are frequently classed as separate from territory wools and designated by the state in which they were produced.

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